



TITLE:

# ADDITIONAL REPORT ON CALANOID COPEPODS FROM THE IZU REGION -PART 4. HALOPTILUS, AUGAPTILUS, CENTRAUGAPTILUS, PSEUD AUGAPTILUS, AND PACHYPTILUS-

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**ADDITIONAL REPORT ON CALANOID COPEPODS  
FROM THE IZU REGION  
PART 4. *HALOPTILUS*, *AUGAPTILUS*, *CENTRAUGAPTILUS*,  
*PSEUDAUGAPTILUS*, AND *PACHYPTILUS***

OTOHIKO TANAKA<sup>1)</sup> and MAKOTO OMORI<sup>2)</sup>

*With 7 Text-figures*

The species studied in the series of additional report on calanoid copepods from the Izu region have been collected by the R/V *Tansei Maru* of the Ocean Research Institute, University of Tokyo, in 1964 and 1965. Sampling data including date, locality, sampling method, and depth is given in Part 1 of the report. Figure 1 shows approximate position of the sampling stations. The present paper deals with taxonomy of 17 species in 5 genera of Augaptilidae (Table 1). *Haloptilus chierchiae*, *H. validus*, and *Pseudaugaptilus polaris* have not previously been known from the surrounding waters of Japan.

Table 1. List of species

|  |   |
|--|---|
| 1. <i>Haloptilus chierchiae</i> (GIESBRECHT) | 10. <i>Augaptilus megalurus</i> GIESBRECHT  |
| 2. <i>H. longicornis</i> (CLAUS)             | 11. <i>Centraugaptilus cuculatus</i> (SARS) |
| 3. <i>H. ornatus</i> (GIESBRECHT)            | 12. <i>C. horridus</i> (FARRAN)             |
| 4. <i>H. oxycephalus</i> (GIESBRECHT)        | 13. <i>C. rattrayi</i> (T. SCOTT)           |
| 5. <i>H. spiniceps</i> (GIESBRECHT)          | 14. <i>Pseudaugaptilus polaris</i> BRODSKY  |
| 6. <i>H. validus</i> SARS                    | 15. <i>Pachyptilus abbreviatus</i> (SARS)   |
| 7. <i>H. species</i>                         | 16. <i>P. eurygnathus</i> SARS              |
| 8. <i>Augaptilus glacialis</i> SARS          | 17. <i>P. pacificus</i> JOHNSON             |
| 9. <i>A. longicaudatus</i> (CLAUS)           |   |

**HALOPTILUS GIESBRECHT, 1898**

*Haloptilus chierchiae* (GIESBRECHT, 1889)

(Fig. 2, a-g)

*Hemicalanus chierchiae* GIESBRECHT, 1889, p. 813; GIESBRECHT, 1892, p. 384, pl. 27 figs. 16, 17, 25, pl. 42 figs. 2, 27, 28.

*Haloptilus chierchiae* (GIESBRECHT).—SARS, 1925, p. 245, pl. 70; SEWELL, 1947, p. 190, fig. 49.

1) 60 Sangenchaya-machi, Setagaya-ku, Tokyo.

2) Ocean Research Institute, University of Tokyo, Nakano, Tokyo.

*Occurrence:* Sta. 115-2, 1♀.

*Descriptive notes:* Female, 5.25 mm. The cephalothorax and abdomen are in the proportional lengths 82:18. The cephalothorax is 2.4 times as long as wide.

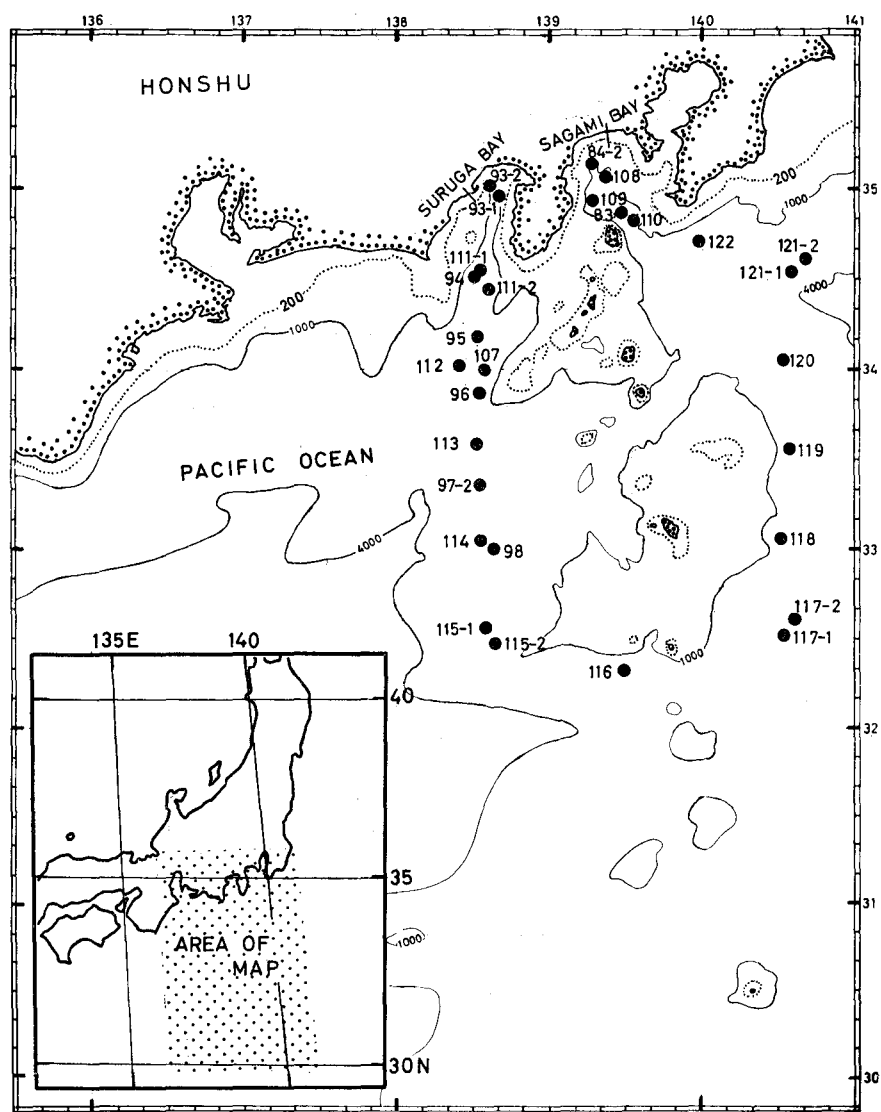


Fig. 1. Position of zooplankton sampling stations in the Izu region.

The ventral surface of the oral region is much swollen. The frontal margin of the head is produced when viewed dorsally. The lateral distal margin of the last thoracic segment is narrowly rounded.

The abdominal segments and furca are in the following proportional lengths:

| segment | 1-2 | 3 | 4 | 5  | furca |      |
|---------|-----|---|---|----|-------|------|
|         | 42  | 9 | 8 | 13 | 28    | =100 |

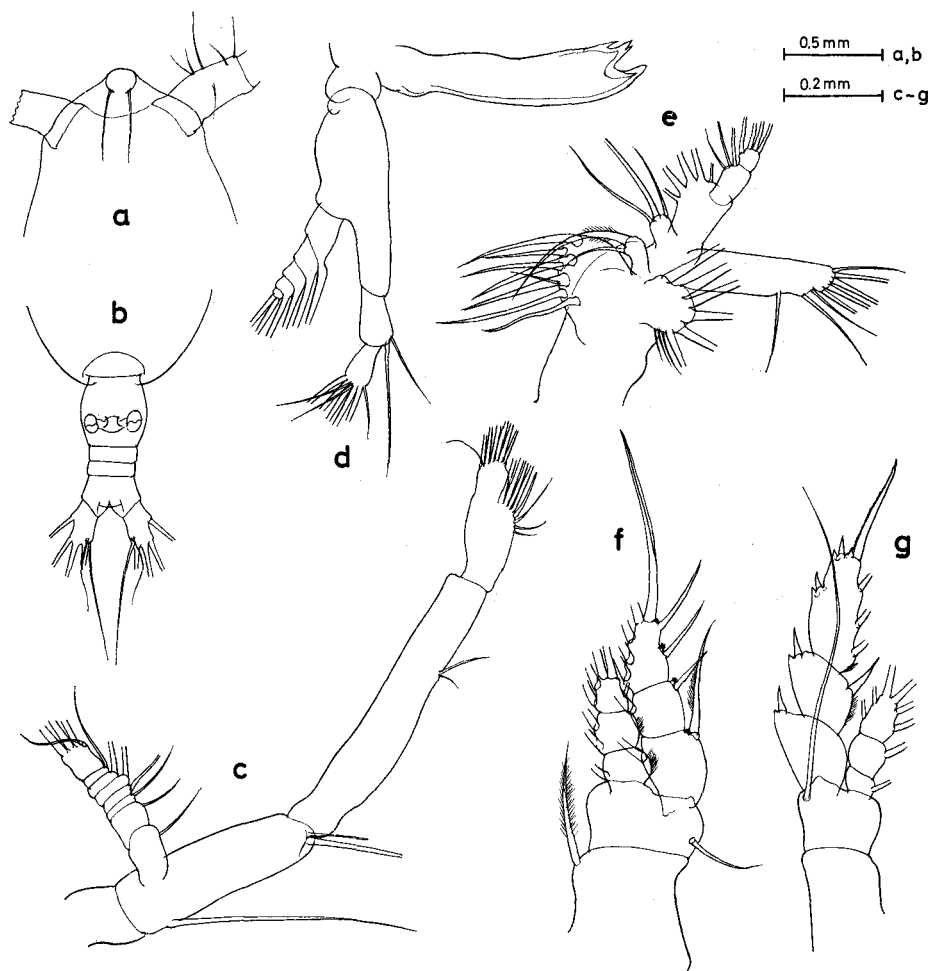


Fig. 2. *Haloptilus chierchiae* (GIESBRECHT), female: a, head, ventral view; b, last thoracic segment and abdomen, ventral view; c, 2nd antenna; d, mandible; e, 1st maxilla; f, 1st leg; g, 5th leg.

The genital segment is a little longer than wide; it is swollen laterally; the genital protuberance is not remarkable. The furca is twice as long as wide.

The 1st antenna exceeds the furca by distal 7 segments; it measures 6.46 mm in length; the segments are in the following proportional lengths:

|         |    |    |    |    |    |    |    |    |    |         |    |    |    |    |
|---------|----|----|----|----|----|----|----|----|----|---------|----|----|----|----|
| segment | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10      | 11 | 12 | 13 | 14 |
|         | 58 | 14 | 13 | 19 | 26 | 27 | 26 | 27 | 30 | 33      | 35 | 43 | 49 | 51 |
| 15      | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25      |    |    |    |    |
| 51      | 54 | 59 | 59 | 48 | 42 | 46 | 45 | 56 | 54 | 35=1000 |    |    |    |    |

Segments 3, 4, 7, 9, 12, 14, 18, 21, 23, 24, and 25 each have a long seta; the setae are more than 8 times the length of the 25th segment.

The 2nd antenna with endopod 2.4 times the length of the exopod; the exopod is 8-segmented; the 1st to 7th segments each have a seta; the endopod has 8 setae on the inner lobe and 7 setae on the outer lobe. The mandible is well-developed; the exopod has 6 setae; the endopod has 6+2 setae on the distal segment; the cutting blade consists of 2 large teeth and 1 small tooth. The 1st maxilla has the following number of setae on the various lobes: 6 large and 3 small setae on the outer lobe, 7 setae on the exopod, 4 setae on the distal segment of the endopod, 3 setae on the 1st segment of the endopod, 5 setae on the 2nd basal segment, 3 setae on the 3rd inner lobe, 2 setae on the 2nd inner lobe, and 8 setae on the 1st inner lobe; the distal seta on the 2nd inner lobe is very strong. The 2nd maxilla has the following number of setae on the various lobes and endopod:

|       |   |   |   |   |   |   |    |
|-------|---|---|---|---|---|---|----|
| lobe  | 1 | 2 | 3 | 4 | 5 | 6 | Ri |
| setae | 3 | 3 | 3 | 2 | 2 | 3 | 6  |

In the maxilliped the 1st and 2nd basal segments are equal in length; the number of setae on the lobes and endopod is as follows:

|       |    |   |   |    |   |         |    |   |   |   |   |
|-------|----|---|---|----|---|---------|----|---|---|---|---|
|       | B1 |   |   | B2 |   |         | Ri |   |   |   |   |
| lobe  | 1  | 2 | 3 | 1  | 2 | segment | 1  | 2 | 3 | 4 | 5 |
| setae | 2  | 3 | 3 | 2  | 2 |         | 4  | 4 | 4 | 3 | 4 |

The distal setae are fringed with fine spinules.

In the 1st leg the 2nd basal segment has a retroverted seta; the outer marginal spine on the 1st segment of the exopod is long, and extends to the distal margin of the 3rd segment; the 2nd segment of the exopod has 1 spine; the 3rd segment of the exopod has fairly long 2 spines. In the 5th leg the 2nd basal segment has a long seta which exceeds the distal margin of the exopod; the 2nd segment of the exopod has an inner marginal spine which extends to the base of the proximal inner marginal seta on the 3rd segment of the exopod.

*Remarks:* This is the first record of occurrence of the species from the surrounding waters of Japan.

*Distribution and size variation:*

| Author                   | Locality            | Depth (m) | Length (mm) |      |
|--------------------------|---------------------|-----------|-------------|------|
|                          |                     |           | ♀           | ♂    |
| GIESBRECHT, 1889         | 99°W, 3°S           | 0-1800    | 4.8         | —    |
| WOLFENDEN, 1911          | Equatorial Atlantic | 0-300     | —           | —    |
| SARS, 1925               | Off Canary Is.      | 0-1000    | 5.10        | —    |
| SEWELL, 1947             | Arabian Sea         | 0-1500    | 4.6-4.8     | 4.05 |
| WILSON, 1950             | Off Peru            | 0-550     | —           | —    |
| GRICE and HULSEMAN, 1967 | Arabian Sea         | 1000-2000 | —           | —    |
| <i>Present record</i>    | Izu region          | 0-2500    | 5.25        | —    |

*Haloptilus longicornis* (CLAUS, 1863)

*Hemicalanus longicornis* CLAUS, 1863, p. 179, pl. 29 fig. 1; BRADY, 1883, p. 44, pl. 9 figs. 1-7; GIESBRECHT, 1892, p. 384, pl. 1 fig. 4, pl. 2 fig. 13, pl. 27 figs. 3, 8-10 23, 27, 29, 33, pl. 42 figs. 15, 29.

*Haloptilus longicornis* (CLAUS).—SARS, 1902, p. 121, pl. 82, pl. 83 fig. 1; MORI, 1937, p. 75, pl. 38 figs. 5-14; TANAKA, 1964b, p. 39, fig. 192; Park, 1970, p. 535, figs. 325-329.

*Occurrence:* Sta. 94, 2♀; Sta. 97-2, 1♀; Sta. 98, 1♀; Sta. 107, 1♀; Sta. 115-1, 3♀; Sta. 115-2, 2♀.

*Remarks:* The species has been recorded from many localities in the Atlantic, Indian, and Pacific Oceans. The species is abundant both in deep and surface layers in the Izu region.

*Distribution and size variation:*

| Author                | Locality              | Depth (m) | Length (mm) |      |
|-----------------------|-----------------------|-----------|-------------|------|
|                       |                       |           | ♀           | ♂    |
| BRADY, 1883           | South Pacific         | —         | 2.5         | —    |
| GIESBRECHT, 1892      | Temperate Atlantic    | —         | 2.1-2.5     | 1.18 |
| SARS, 1902            | Norwegian waters      | —         | 2.15        | —    |
| A. SCOTT, 1909        | Malay Archipelago     | 0-200     | —           | —    |
| FARRAN, 1926          | Bay of Biscay         | 0-1830    | 1.98-2.07   | —    |
| FARRAN, 1929          | Off New Zealand       | 0-3       | 2.04-2.16   | —    |
| FARRAN, 1936          | Great Barrier Reef    | 0-600     | 1.98-2.45   | —    |
| MORI, 1937            | Off Kii Peninsula     | 0-100     | 2.3         | —    |
| GRICE, 1962           | Equatorial Pacific    | 63-119    | 1.77-1.90   | —    |
| BJORNBERG, 1963       | Off Brazil            | 0-85      | 2.1         | —    |
| TANAKA, 1964b         | Izu region            | 0         | 2.14-2.25   | 1.16 |
| VERVOORT, 1965        | Gulf of Guinea        | 0-175     | 1.94-2.23   | —    |
| OWRE and FOYO, 1967   | Florida Current       | 0-318     | —           | —    |
| PARK, 1968            | Central North Pacific | 0-140     | 2.00-2.44   | —    |
| PARK, 1970            | Caribbean Sea         | 0-100     | 2.00-2.16   | 1.24 |
| <i>Present record</i> | Izu region            | 0-1800    | 2.10-2.63   | —    |

*Haloptilus ornatus* (GIESBRECHT, 1892)

*Hemicalanus ornatus* GIESBRECHT, 1892, p. 384, pl. 27 figs. 1, 6, 7, 14, 15, 21, 24, 38, pl. 42, figs. 1, 9, 17, 19, 22, 24.

*Haloptilus ornatus* (GIESBRECHT).—GIESBRECHT and SCHMEL, 1898, p. 120, fig. 28; SARS, 1925, p. 247, pl. 73 figs. 1–5, MORI, 1937, p. 75, pl. 39 figs. 5–8, GRICE, 1962, p. 223, pl. 25 figs. 12–16.

*Occurrence*: Sta. 84–2, 1♀; Sta. 97–2, 1♀; Sta. 98, 5♀; Sta. 110, 1♀; Sta. 113, 1♀; Sta. 114, 3♀; Sta. 115–1, 3♀; Sta. 115–2, 5♀; Sta. 116, 1♀; Sta. 118, 1♀.

*Remarks*: The body length of a specimen from Sta. 98 is 2.88 mm, but that of others ranges from 4.04 to 4.96 mm. The small specimen differs from the larger ones in the number of setae on various lobes of the 1st maxilla: the exopod with 4 long and 2 small setae, the endopod with 2 setae, the 2nd basal segment with 4 setae, and the 3rd inner lobe with 2 setae. In the larger specimens the exopod with 9 setae, the endopod with 2 setae, the 2nd basal segment with 5 setae, and the 3rd inner lobe with 3 setae; this arrangement of the setae agrees exactly with the figure given by SARS (1925). According to SARS (1925), the rostral filaments are absent in this species. However, 2 small filaments are observed on the rostrum in the specimens from the Izu region.

*Distribution and size variation*:

| Author                | Locality              | Depth (m) | Length (mm) |           |
|-----------------------|-----------------------|-----------|-------------|-----------|
|                       |                       |           | ♀           | ♂         |
| GIESBRECHT, 1982      | Western Mediterranean | —         | 4.6–4.8     | 2.75–3.05 |
| A. SCOTT, 1909        | Celebes Sea           | 0–700     | —           | —         |
| SARS, 1925            | Temperate Atlantic    | 0         | 5.0         | —         |
| MORI, 1937            | Off Kii Peninsula     | 0–100     | 3.0–5.0     | —         |
| SEWELL, 1947          | Arabian Sea           | 0–500     | 4.4–4.5     | —         |
| WILSON, 1950          | Off Hawaii            | 0–183     | —           | —         |
| CHIBA, 1956           | Equatorial Pacific    | —         | 3.0–4.2     | —         |
| GRICE, 1962           | Equatorial Pacific    | 0–169     | 4.56        | —         |
| TANAKA, 1964b         | Sagami Bay            | 0         | 4.54        | —         |
| VERVOORT, 1965        | Gulf of Guinea        | 130–600   | 4.30–4.80   | —         |
| <i>Present record</i> | Izu region            | 0–520     | 2.88–4.94   | —         |

*Haloptilus oxycephalus* (GIESBRECHT, 1889)

*Hemicalanus oxycephalus* GIESBRECHT, 1889, p. 813; GIESBRECHT, 1892, p. 384, pl. 42 figs. 7, 16, 23.

*Haloptilus oxycephalus* (GIESBRECHT).—SARS, 1925, p. 252, pl. 74 figs. 12–16; MORI, 1937, p. 77, pl. 40 figs. 1, 2; VERVOORT, 1957, p. 136, figs. 128–130; BRODSKY, 1962, p. 132, fig. 34; BRADFORD, 1971, p. 27, figs. 120–124.

*Occurrence*: Sta. 84–2, 1♀; Sta. 108, 1♀; Sta. 110, 1♀; Sta. 115–2, 1♀; Sta. 122, 2♀.

*Distribution and size variation*:

| Author       | Locality        | Depth (m) | Length (mm) |   |
|--------------|-----------------|-----------|-------------|---|
|              |                 |           | ♀           | ♂ |
| SARS, 1925   | Bay of Biscay   | 0–2000    | 3.50        | — |
| FARRAN, 1929 | Off New Zealand | 4         | 4.02–4.08   | — |
| MORI, 1937   | Off Hachijo Is. | 0–60      | 3.0         | — |
| SEWELL, 1947 | Arabian Sea     | 0–500     | —           | — |

|                       |                      |         |           |      |
|-----------------------|----------------------|---------|-----------|------|
| WILSON, 1950          | Off Hawaii           | 0-183   | —         | —    |
| VERVOORT, 1957        | Antarctic waters     | 100-250 | 3.38-4.95 | 2.57 |
| BRODSKY, 1962         | Northwestern Pacific | 0       | 3.25      | —    |
| TANAKA, 1964b         | Suruga Bay           | 0-1000  | 3.56      | —    |
| VERVOORT, 1965        | Gulf of Guinea       | 0-100   | 3.30-3.70 | 2.50 |
| BRADFORD, 1971        | Ross Sea             | 0-1000  | 3.1       | 2.85 |
| <i>Present record</i> | Izu region           | 0-740   | 3.64-5.00 | —    |

*Haloptilus spiniceps* (GIESBRECHT, 1892)

*Hemicalanus spiniceps* GIESBRECHT, 1892, p. 384, pl. 27 figs. 5, 20, 35, 40, pl. 42 figs. 3, 8, 10, 11, 21, 25.

*Haloptilus spiniceps* (GIESBRECHT).—SARS, 1925, p. 249, pl. 73 figs. 6-10; MORI, 1937, p. 76, pl. 39 figs. 9-14; GRICE, 1962, p. 223, pl. 25 figs. 17-20, pl. 26. figs. 1-5.

*Occurrence*: Sta. 114, 1♀.

*Distribution and size variation*:

| Author                | Locality               | Depth (m) | Length (mm) |        |
|-----------------------|------------------------|-----------|-------------|--------|
|                       |                        |           | ♀           | ♂      |
| GIESBRECHT, 1892      | Western Mediterranean  | —         | 3.8-4.3     | 2.55   |
| A. SCOTT, 1909        | Banda Sea              | 0-200     | —           | —      |
| SARS, 1925            | South Off Azores       | 0-500     | 4.10        | —      |
| FARRAN, 1929          | Off New Zealand        | 2         | 4.56        | —      |
| FARRAN, 1936          | Off Great Barrier Reef | 0-180     | 4.02        | —      |
| MORI, 1937            | Kii Channel            | 0-150     | —           | 2.3(V) |
| GRICE, 1962           | Equatorial Pacific     | 72-146    | 3.70-3.99   | —      |
| TANAKA, 1964b         | Sagami Bay             | 0-1000    | 2.29(V)     | —      |
| VERVOORT, 1965        | Gulf of Guinea         | 0-600     | 3.95-5.45   | —      |
| PARK, 1968            | Central North Pacific  | 0-140     | 4.12-4.99   | —      |
| <i>Present record</i> | Izu region             | 0-930     | 4.07        | —      |

*Haloptilus validus* SARS, 1920

(Fig. 3, a-k)

*Haloptilus validus* SARS, 1920, p. 11; SARS, 1925, p. 241, pl. 98; SEWELL, 1947, p. 194, fig. 50a-g.

*Occurrence*: Sta. 116, 1♀.

*Descriptive notes*: Female, 6.09 mm. The body is elongate ovate, and 3 times as long as wide. The cephalothorax and abdomen are in the proportional lengths 87:13. The frontal margin of the head is produced in a small spinous projection when viewed dorsally. The head is separated from the 1st thoracic segment: the 4th segment is fused with the 5th. The distal lateral margin of the last thoracic segment is rounded. The rostrum is composed of 2 small filaments.

The abdominal segments and furca are in the following proportional lengths:

|         |     |    |   |   |       |      |
|---------|-----|----|---|---|-------|------|
| segment | 1-2 | 3  | 4 | 5 | furca |      |
|         | 51  | 12 | 6 | 6 | 25    | =100 |



The genital segment is as long as wide; the genital protuberance is considerably produced ventrally: the furca is a little longer than wide.

The 1st antenna, 7.08 mm in length, exceeds the end of the furca by distal 5 segments; the segments are in the following proportional lengths:

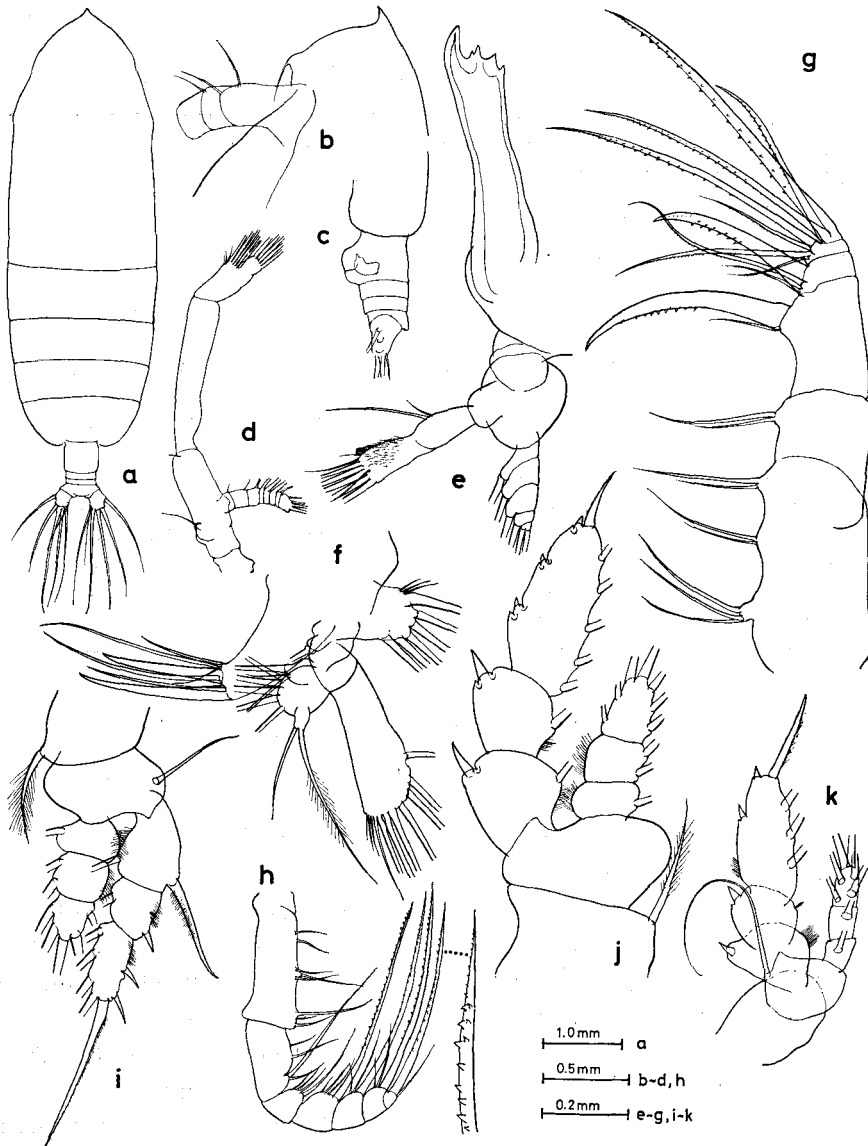


Fig. 3. *Haloptilus validus* Sars, female: a, whole body, dorsal view; b, head, lateral view; c, last thoracic segment and abdomen, lateral view; d, 2nd antenna; e, mandible; f, 1st maxilla; g, 2nd maxilla; h, maxilliped; i, 1st leg; j, 2nd leg; k, 5th leg.

| segment | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11    | 12 | 13 | 14 |
|---------|----|----|----|----|----|----|----|----|----|----|-------|----|----|----|
|         | 73 | 13 | 15 | 13 | 20 | 20 | 26 | 23 | 35 | 31 | 39    | 47 | 52 | 55 |
| 15      | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |       |    |    |    |
| 60      | 63 | 67 | 66 | 58 | 48 | 44 | 38 | 38 | 33 | 23 | =1000 |    |    |    |

In the 2nd antenna the endopod is 3 times the length of the exopod; the exopod is 8-segmented, and each of the 1st to 7th segments carries a seta; the endopod has 8 setae on the inner lobe and 5 setae on the outer lobe. The mandibular palp is devoid of setae; the endopod has 2 setae on the 1st segment and 8 setae on the 2nd segment; the cutting blade has 4 teeth. The 1st maxilla is well-developed; the various lobes have the following number of setae: 6+3 setae on the outer lobe, 11 setae on the elongated exopod, of which the apical 4 are small, 2 setae on the endopod, 5 setae on the 2nd basal segment, 3 setae on the 3rd inner lobe, 1 seta on the 2nd inner lobe, and 7 setae on the 1st inner lobe. The 2nd maxilla is large and carries 3 setae on the 1st lobe and 2 setae on each of the 2nd to 4th lobes; the 5th lobe bears a strong serrated spine and a small seta; the 6th lobe has a stout serrated spine and 2 setae; the endopod bears 2+2+3 setae, of which the distal setae are fringed coarsely with strong spinules. In the maxilliped the 1st basal segment is about twice the length of the 2nd basal segment; the number of setae on the various lobes and endopod is as follows:

|       | B1 |   |   | B2 |   |         | Ri |   |   |   |   |
|-------|----|---|---|----|---|---------|----|---|---|---|---|
| lobe  | 1  | 2 | 3 | 1  | 2 | segment | 1  | 2 | 3 | 4 | 5 |
| setae | 2  | 3 | 3 | 2  | 2 |         | 4  | 4 | 3 | 3 | 2 |

The large setae on the distal 4 segments of the endopod are fringed coarsely with strong spinules.

The 1st leg has a 3-segmented exopod and endopod; the 2nd basal segment has a retroverted seta; the 1st segment of the exopod has a long marginal spine which extends to the base of the 1st marginal spine on the 3rd segment of the exopod. The 2nd to 4th legs each have a 3-segmented exopod and endopod. In the 5th leg the 2nd basal segment has a long seta; the 2nd segment of the exopod has a minute spine on the inner margin.

*Remarks:* The species is easily recognized by the structure of the 2nd maxilla and maxilliped. This is the first record of occurrence of the species from the Pacific Ocean.

*Distribution and size variation:*

| Author                   | Locality       | Depth (m) | Length (mm) |   |
|--------------------------|----------------|-----------|-------------|---|
|                          |                |           | ♀           | ♂ |
| SARS, 1925               | North Atlantic | 0-1000    | 6.30        | — |
| SEWELL, 1947             | Arabian Sea    | 400-645   | 6.00        | — |
| GRICE and HULSEMAN, 1967 | Arabian Sea    | 350-940   | —           | — |
| <i>Present record</i>    | Izu region     | 0-1200    | 6.09        | — |

*Haloptilus* species

(Fig. 4, a-g)

*Occurrence:* Sta. 108, 1♀ (juv.)

*Descriptive notes:* Copepodite IV stage female, 4.33 mm. The cephalothorax and abdomen are in the proportional lengths 84:16. The frontal margin of the head is highly vaulted when viewed dorsally. The lateral distal margins of the last thoracic segment are narrowly rounded. The rostrum is represented by a small knob.

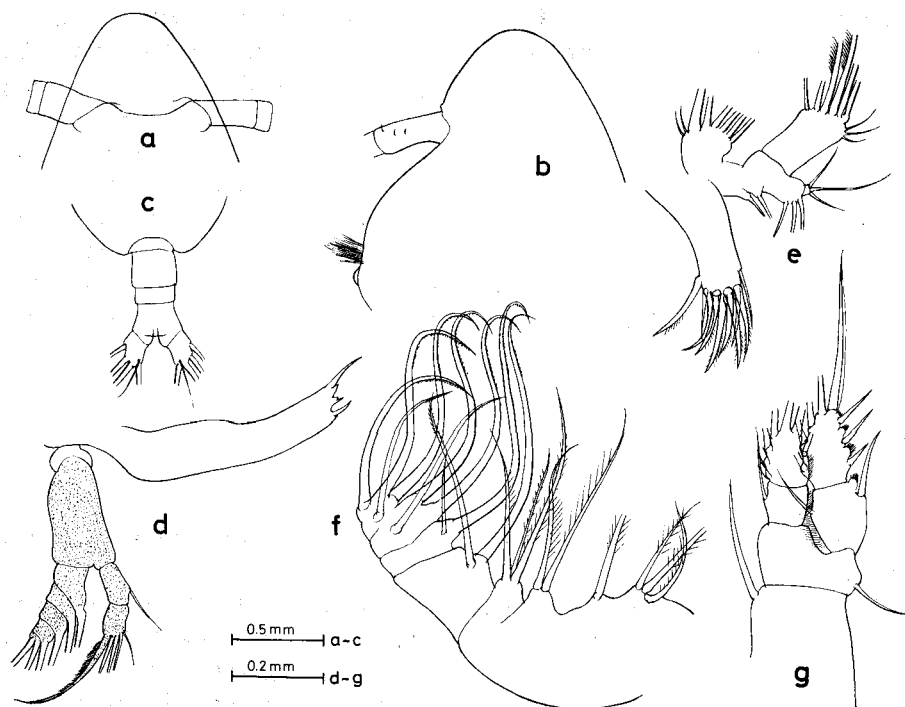


Fig. 4. *Haloptilus* species, immature female: a, head, dorsal view; b, the same, lateral view; c, last thoracic segment and abdomen, dorsal view; d, mandible; e, 1st maxilla; f, 2nd maxilla; g, 1st leg.

The abdomen is 3-segmented; the segments and furca are in the following proportional lengths:

|         |    |    |    |       |      |
|---------|----|----|----|-------|------|
| segment | 1  | 2  | 3  | furca |      |
|         | 35 | 14 | 26 | 25    | =100 |

The furca is 1.3 times as long as wide.

The 1st antenna extends beyond the end of the furca by distal 4 segments; the segments are in the following proportional lengths:

| segment | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10      | 11 | 12 | 13 | 14 |
|---------|----|----|----|----|----|----|----|----|----|---------|----|----|----|----|
|         | 73 | 13 | 18 | 16 | 22 | 24 | 24 | 28 | 29 | 33      | 35 | 51 | 51 | 51 |
| 15      | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25      |    |    |    |    |
| 49      | 47 | 57 | 53 | 59 | 47 | 49 | 51 | 53 | 41 | 26=1000 |    |    |    |    |

In the 2nd antenna the exopod and endopod are about equal in length; the endopod carries 6 setae on the outer lobe and 6 setae on the inner lobe. The mandible is characteristic: the 2nd basal segment is finely granulated; the endopod has 1 seta on the 1st segment; the 2nd segment bears 5 setae on the distal margin, of which the outer one is very long and is furnished with short bristles on the anterior margin; the cutting blade is oblique and has 4 teeth, of which the inner marginal one is slender. The 1st maxilla has the following number of setae on the various lobes: 6 long and 2 small setae on the outer lobe, 6 long and 3 small setae on the exopod, 3 setae on the endopod, 3 setae on the 2nd basal segment, 1 seta on each of the 2nd and 3rd inner lobes, and 10 setae on the 1st inner lobe. The 2nd maxilla has the following number of setae on the various lobes and endopod:

| lobe  | 1 | 2 | 3 | 4 | 5 | 6 | Ri |
|-------|---|---|---|---|---|---|----|
| setae | 3 | 1 | 2 | 3 | 2 | 2 | 7  |

In the maxilliped the 1st and 2nd basal segments and endopod are in the proportional lengths 36:33:31; the number of setae on the various lobes is as follows:

|       | B1 |   |   | B2 |   |         | Ri |   |   |   |   |
|-------|----|---|---|----|---|---------|----|---|---|---|---|
| lobe  | 1  | 2 | 3 | 1  | 2 | segment | 1  | 2 | 3 | 4 | 5 |
| setae | 1  | 3 | 3 | 3  | 2 |         | 2  | 2 | 1 | 1 | 3 |

The distal setae are furnished with button-like organs.

The 1st leg has a 2-segmented exopod and endopod; the 1st basal segment has a retroverted seta. The 2nd to 4th legs each have a 2-segmented exopod and endopod. The 5th pair of legs has an 1-segmented exopod and endopod.

*Remarks:* The present immature specimen appears to be referable the genus *Haloptilus*, but not to either of the preceding 6 species.

### AUGAPTILUS GIESBRECHT, 1892

#### *Augaptilus glacialis* Sars, 1900

(Fig. 5, a)

*Augaptilus glacialis* Sars, 1900, p. 88, pls. 26, 27; Sars, 1925 p. 254, pl. 76 figs. 1-16; Brodsky, 1950, p. 367, fig. 258; Vervoort, 1951, p. 144, figs. 80, 81; Tanaka, 1964b, p. 77, fig. 212; Vervoort, 1965, p. 130.

*Augaptilus zetosios* Wolfenden, 1902, p. 369, pl. 3.

*Occurrence:* Sta. 83, 1♀; Sta. 107, 1♀; Sta. 110, 2♀; Sta. 115-2, 4♀; Sta. 116, 1♀.

*Distribution and size variation:*

| Author                | Locality              | Depth (m) | Length (mm) |           |
|-----------------------|-----------------------|-----------|-------------|-----------|
|                       |                       |           | ♀           | ♂         |
| WOLFENDEN, 1902       | Faroe Channel         | —         | 4.71        | —         |
| SARS, 1925            | North Atlantic        | 0-1800    | 5.3         | —         |
| BRODSKY, 1950         | Arctic Ocean          | 200-2500  | 4.6-5.3     | 4.4-5.1   |
| VERVOORT, 1951        | Antarctic Ocean       | 0-900     | —           | 4.43      |
| VERVOORT, 1957        | Southern Indian Ocean | 250-500   | 5.72        | —         |
| Johnson, 1963         | Arctic Ocean          | 200-1000  | —           | —         |
| TANAKA, 1964b         | Sagami Bay            | 0-1000    | 5.88        | 5.19      |
| VERVOORT, 1965        | Gulf of Guinea        | 0-600     | 4.10-4.90   | 3.70-3.80 |
| <i>Present record</i> | Izu region            | 0-1200    | 4.03-5.90   | —         |

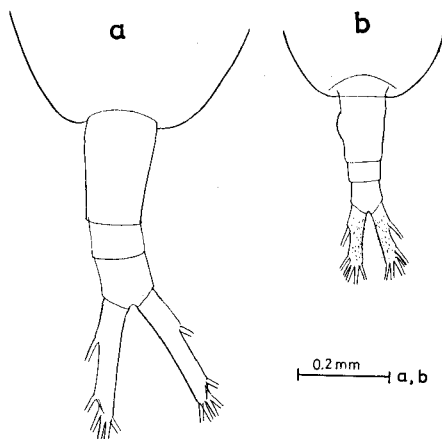


Fig. 5. a, *Augaptilus glacialis* Sars, female, last thoracic segment and abdomen, dorsal view; b, *Augaptilus longicaudatus* (Claus), female, the same, dorsal view.

*Augaptilus longicaudatus* (CLAUS, 1863)

(Fig. 5, b)

*Hemicalanus longicaudatus* CLAUS, 1863, p. 179, pl. 29.

*Augaptilus longicaudatus* (CLAUS).—GIESBREGHT, 1892, p. 400, pl. 27 fig. 31, pl. 28 figs. 2, 8, 11, 19, 23, 31, 32, 35, 38, 39, pl. 29 fig. 22, pl. 39 figs. 37, 48; SARS, 1925, p. 256, pl. 76 figs. 17, 18; GRICE, 1962, p. 226, pl. 26, figs. 6-14;

*Occurrence:* Sta. 83, 1♀; Sta. 98, 2♀; Sta. 108, 1♀; Sta. 115-2, 1♀; Sta. 117-1, 1♀; Sta. 118, 1♀; Sta. 121-1, 1♀.

*Remarks:* Female specimens of *Augaptilus longicaudatus* and *A. glacialis* resemble each other not only in the general appearance but also in the structure of the mouth appendages and swimming legs. The former species is characterized by remarkable

swellings on the lateral margins of the genital segment and by possessing small spiniform hairs on the furca. The latter has less remarkable swellings on the lateral margins of the genital segment. However, as discussed by VERVOORT (1965), it is not easy to separate *A. longicaudatus* from *A. glacialis* so far as the female is concerned. The great variability in length of the species shown by Farran (1908) is incredible. The species has been recorded from various localities of the Atlantic, Indian, and Pacific Oceans.

*Distribution and size variation:*

| Author                | Locality               | Depth (m) | Length (mm) |           |
|-----------------------|------------------------|-----------|-------------|-----------|
|                       |                        |           | ♀           | ♂         |
| GIESBRECHT, 1892      | Central Pacific        | 0-1000    | 3.7-3.85    | 3.2-3.35  |
| ESTERLY, 1905         | San Diego region       | —         | —           | 3.39      |
| FARRAN, 1908          | Irish Atlantic slope   | 180-2070  | 3.6-6.1     | —         |
| A. SCOTT, 1909        | Malay Archipelago      | 0-750     | —           | —         |
| SARS, 1925            | North Atlantic         | 0-1000    | 3.60        | —         |
| FARRAN, 1926          | Bay of Biscay          | 0-590     | 3.7-4.3     | 3.6-3.76  |
| FARRAN, 1929          | Off New Zealand        | 0-100     | 2.04-2.16   | —         |
| FARRAN, 1936          | Off Great Barrier Reef | 0-600     | 3.72        | —         |
| SEWELL, 1947          | Arabian Sea            | 0-500     | 3.67        | —         |
| TANAKA, 1964b         | Sagami Bay             | 0-1000    | 3.82        | —         |
| VERVOORT, 1965        | Gulf of Guinea         | 0-35      | 3.50-4.03   | 3.45-3.80 |
| OWRE and FOYO, 1967   | Florida Current        | 525       | —           | —         |
| <i>Present record</i> | Izu region             | 0-850     | 3.22-4.07   | —         |

*Augaptilus megalurus* GIESBRECHT, 1889

*Augaptilus megalurus* GIESBRECHT, 1889, p. 814; GIESBRECHT, 1892, p. 400, pl. 27 fig. 28, pl. 28 fig. 7, pl. 29 fig. 20, pl. 39 fig. 47; SARS, 1925, p. 257, pl. 77 figs. 1-9.

*Augaptilus anceps* TANAKA, 1964b, p. 75, fig. 211.

*Occurrence:* Sta. 111-1, 1♀; Sta. 112, 1♀; Sta. 114, 1♀; Sta. 115-1, 1♀; Sta. 117-2, 1♀.

*Remarks:* The species previously described by Tanaka (1964b) as *Augaptilus anceps* is *A. megalurus*. The geographical distribution of the species has been discussed by VERVOORT (1965).

*Distribution and size variation:*

| Author                | Locality             | Depth (m) | Length (mm) |      |
|-----------------------|----------------------|-----------|-------------|------|
|                       |                      |           | ♀           | ♂    |
| GIESBRECHT, 1892      | Central Pacific      | 0-1000    | 4.5         | 4.0  |
| FARRAN, 1908          | Irish Atlantic slope | 1080-1260 | 5.7-6.1     | 5.0  |
| SARS, 1926            | North Atlantic       | 0-500     | 4.50        | —    |
| TANAKA, 1964b         | Sagami Bay           | 0-1000    | 5.0         | 4.23 |
| VERVOORT, 1965        | Gulf of Guinea       | 0-600     | 4.30-4.60   | —    |
| <i>Present record</i> | Izu region           | 0-921     | 4.64-5.40   | —    |

## CENTRAUGAPTILUS SARS, 1920

*Centraugaptilus cuculatus* (SARS, 1905)

(Fig. 6, a-c)

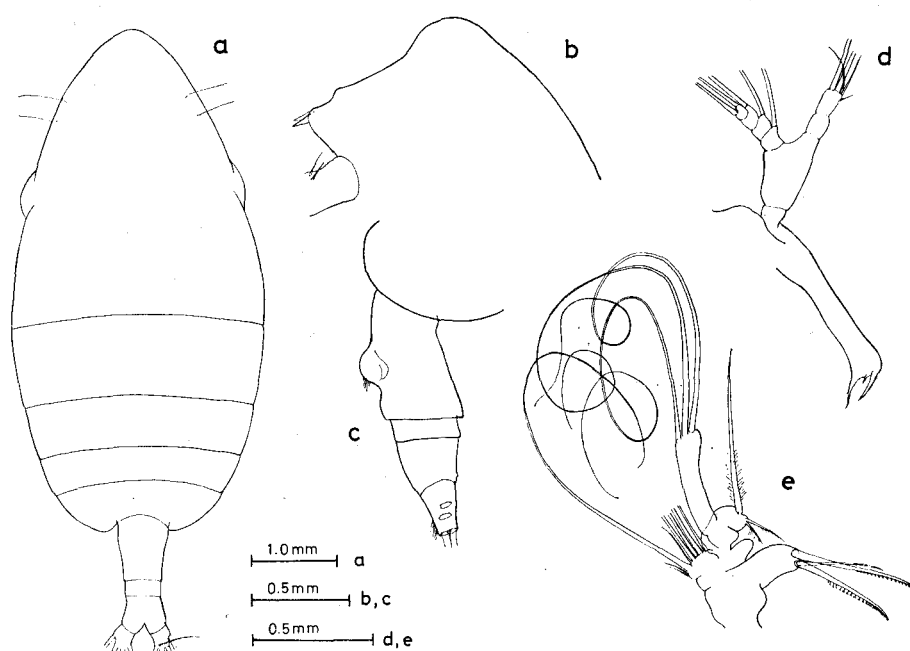
*Augaptilus cuculatus* SARS, 1905, p. 17.*Centraugaptilus cuculatus* (SARS).—Sars, 1925, p. 306, pl. 107 figs. 1–10, TANAKA and OMORI, 1967, p. 258.*Occurrence*: Sta. 111–2, 1♀.*Remarks*: The present specimen is unusually large in size (10.20 mm), but a specimen taken by the horizontal tow at a depth of 750 m in Suruga Bay is 7.60 mm

Fig. 6. *Centraugaptilus cuculatus* (SARS), female: a, whole body; b, head, lateral view; c, last thoracic segment and abdomen, lateral view; d, mandible; e, 1st maxilla.

in length. As noted previously (TANAKA and OMORI, 1967), there are no structural differences between the large and small specimens. The mandible has 5 setae on the distal segment of the endopod. In the 1st maxilla the various lobes have the following number of setae: 8 setae on the outer lobe, of which the proximal 2 are very small; 3 large setae on the exopod; a strong seta on the endopod, 2 small setae on the 2nd basal segment, 3 setae on the 1st inner lobe; the 2nd and 3rd inner lobes lack the seta. Distribution and size variation are summarized by TANAKA and OMORI (1967).

*Centraugaptilus horridus* (FARRAN, 1908)

*Augaptilus horridus* FARRAN, 1908, p. 78, pl. 8 fig. 20.

*Centraugaptilus horridus* (FARRAN).—SARS, 1925, p. 307, pl. 107 figs. 11–18; SEWELL, 1932, p. 326, fig. 107; TANAKA, 1964b, p. 83, fig. 215.

*Augaptilus pyramidalis* ESTERLY, 1911, p. 334, pl. 26 figs. 1, 9, pl. 30 fig. 69, pl. 32 fig. 106.

*Centraugaptilus pyramidalis* (ESTERLY).—BRODSKY, 1950, p. 389, fig. 276.

*Occurrence:* Sta. 94, 1 ♀; Sta. 107, 1 ♀; Sta. 108, 1 ♀; Sta. 111–2, 2 ♀; Sta. 114, 1 ♀; Sta. 122, 1 ♀.

*Distribution and size variation:*

| Author                 | Locality             | Depth (m) | Length (mm) |      |
|------------------------|----------------------|-----------|-------------|------|
|                        |                      |           | ♀           | ♂    |
| FARRAN, 1908           | Irish Atlantic slope | 1134–2070 | 10.0        | —    |
| ESTERLY, 1911          | San Diego region     | 0–450     | 6.68        | —    |
| SARS, 1925             | North Atlantic       | 0–1500    | 9.6         | —    |
| SEWELL, 1932           | Bay of Bengal        | 0–720     | —           | 8.4  |
| SEWELL, 1947           | Arabian Sea          | 0–1500    | 6.0–7.0     | —    |
| TANAKA, 1964b          | Sagami Bay           | 0–1000    | 9.45        | 8.33 |
| VERVOORT, 1965         | Gulf of Guinea       | 0–600     | 5.60–8.55   | —    |
| TANAKA and OMORI, 1967 | Northwestern Pacific | 0–1430    | 8.8–10.1    | —    |
| <i>Present record</i>  | Izu region           | 0–900     | 7.21–9.68   | —    |

*Centraugaptilus rattrayi* (T. SCOTT, 1894)

*Augaptilus rattrayi* T. SCOTT, 1894, p. 36, pl. 2, figs. 25–37; FARRAN, 1908, p. 78, pl. 8 fig. 21.

*Centraugaptilus rattrayi* (T. SCOTT).—SARS, 1925, p. 304, pl. 106; TANAKA, 1964b, p. 81, fig. 214.

*Augaptilus macrodus* ESTERLY, 1911, p. 332, pl. 27 fig. 18, pl. 29 fig. 44, pl. 30 figs. 72, 74, pl. 31 fig. 87, pl. 32 fig. 112.

*Centraugaptilus macrodus* (ESTERLY).—BRODSKY, 1950, p. 388, fig. 275.

*Occurrence:* Sta. 94, 1 ♀; Sta. 107, 1 ♀; Sta. 108, 1 ♀; Sta. 109, 2 ♀; Sta. 110, 1 ♀; Sta. 111–2, 1 ♀; Sta. 115–1, 1 ♀; Sta. 115–2, 1 ♂; Sta. 118, 1 ♀; Sta. 120, 1 ♀; Sta. 121–2, 1 ♂.

*Distribution and size variation:*

| Author                | Locality         | Depth (m) | Length (mm) |            |
|-----------------------|------------------|-----------|-------------|------------|
|                       |                  |           | ♀           | ♂          |
| T. SCOTT, 1898        | Gulf of Guinea   | 0–183     | 4.9         | —          |
| ESTERLY, 1911         | San Diego region | 0–595     | 5.31        | —          |
| SARS, 1925            | North Atlantic   | 0–1000    | 6.0         | —          |
| FARRAN, 1926          | Bay of Biscay    | 135–540   | 5.52–6.18   | —          |
| SEWELL, 1932          | Laccadive Sea    | 0–1260    | 4.8         | —          |
| TANAKA, 1964b         | Sagami Bay       | 0–1000    | 5.80        | —          |
| VERVOORT, 1965        | Gulf of Guinea   | 0–600     | 4.70–5.70   | 4.98       |
| <i>Present record</i> | Izu region       | 0–680     | 5.15–5.87   | 4.80, 4.85 |



## PSEUDAUGAPTILUS SARS, 1907

*Pseudaugaptilus polaris* BRODSKY, 1950

(Fig. 7, a-k)

*Pseudaugaptilus polaris* BRODSKY, 1950, p. 391, fig. 278; MORRIS, 1970, p. 2316, fig. 11.*Occurrence:* Sta. 84-2, 1 ♀; Sta. 110, 1 ♀.

*Descriptive notes:* Female, 5.77 mm. The cephalothorax and abdomen are in the proportional lengths 78:22. The head is separated from the 1st thoracic segment; the 4th and 5th thoracic segments are fused. The frontal margin of the head is produced when viewed dorsally. The lateral margin of the last thoracic segment is bluntly rounded. The rostral filaments are very long.

The abdominal segments and furca are in the following proportional lengths:

|         |     |    |    |   |       |      |
|---------|-----|----|----|---|-------|------|
| segment | 1-2 | 3  | 4  | 5 | furca |      |
|         | 43  | 14 | 10 | 9 | 24    | =100 |

The ventral surface of the genital segment is produced. The furca is 1.7 times as long as wide; the outer marginal seta is the largest, and the accessory seta is small.

The 1st antenna exceeds a little the end of the furca; it measures 6.27 mm in length. The segments are in the following proportional lengths:

|         |    |    |    |    |    |    |    |    |    |    |    |       |    |    |
|---------|----|----|----|----|----|----|----|----|----|----|----|-------|----|----|
| segment | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12    | 13 | 14 |
|         | 95 | 27 | 35 | 35 | 35 | 35 | 32 | 32 | 33 | 33 | 37 | 43    | 46 | 48 |
| 15      | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |    |       |    |    |
|         | 49 | 51 | 51 | 48 | 40 | 27 | 27 | 19 | 21 | 49 | 52 | =1000 |    |    |

In the 2nd antenna the endopod is 1.2 times the length of the exopod; the exopod is 7-segmented; the 1st and 2nd segments are partially fused; the 7th segment is elongated, and is nearly as long as the combined lengths of the 1st to 6th segments; the endopod has 6 long setae on the inner lobe, and 5 long and 2 small setae on the outer lobe. The mandibular palp is well-developed; the exopod and endopod are equal in length; the exopod has 6 setae; the endopod has 1 seta on the 1st segment and 5 setae on the distal margin of the 2nd segment; the cutting blade is small and has 3 groups of complicated teeth. In the 1st maxilla the outer lobe is devoid of any setae; the exopod has 2 long setae; the endopod has 2 setae, of which the distal one is long; the 2nd basal segment has 1 long seta; the 2nd and 3rd inner lobes each have 1 seta; the 1st inner lobe has 7 setae. In BRODSKY's (1950) specimen the 2nd and 3rd inner lobes each have 2 setae. The 2nd maxilla resembles that of *Pseudaugaptilus longiremis* SARS; the number of setae on the various lobes and endopod is as follows:

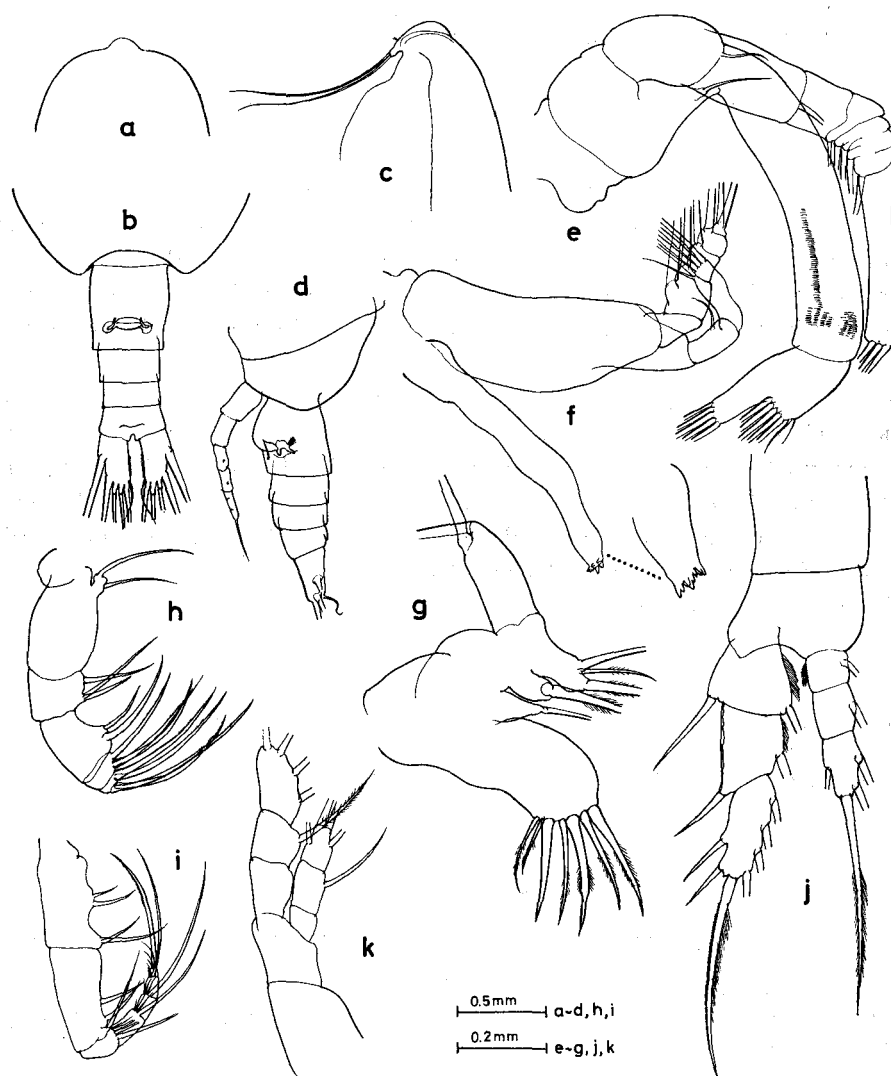


Fig. 7. *Pseudaugaptilus polaris* BRODSKY, female: a, head, dorsal view; b, the same, lateral view; c, last thoracic segment, dorsal view; d, the same, lateral view; e, 2nd antenna; f, mandible; g, 1st maxilla; h, 2nd maxilla; i, maxilliped; j, 1st leg; k, 5th leg.

| lobe  | 1 | 2 | 3 | 4 | 5 | 6 | Ri |
|-------|---|---|---|---|---|---|----|
| setae | 2 | 0 | 1 | 2 | 1 | 1 | 7  |

The distal setae are fringed with fine spinules. The maxilliped has the following number of setae on the various lobes:

|       | B1 |   |   | B2 |   | segment | Ri |   |   |   |   |
|-------|----|---|---|----|---|---------|----|---|---|---|---|
| lobe  | 1  | 2 | 3 | 1  | 2 |         | 1  | 2 | 3 | 4 | 5 |
| setae | 0  | 2 | 2 | 2  | 1 |         | 4  | 4 | 4 | 4 | 4 |

The distal setae are fringed with fine spinules.

In the 1st leg the 1st segment of the exopod has a marginal spine which extends nearly to the base of the marginal spine on the 2nd segment; the spines on the 2nd and 3rd segments of the exopod are slender; there is no retroverted seta on the 2nd basal segment. In the 5th leg the inner marginal spine on the 2nd segment of the exopod is fairly long, extending to the base of the inner distal seta on the 3rd segment of exopod.

*Remarks:* *Pseudaugaptilus polaris* resembles *P. longiremis* Sars or *P. orientalis* TANAKA. However, it differs from *P. longiremis* in having the 1st leg which is provided with a marginal spine on the 2nd segment of exopod. The species is distinguished from *P. orientalis* by the following characters; larger in size, longer furca, shorter 1st antenna, and 7-segmented exopod in the 2nd antenna. This is the second record of occurrence of the species from the Pacific Ocean.

*Distribution and size variation:*

| Author                | Locality                  | Depth (m) | Length (mm) |
|-----------------------|---------------------------|-----------|-------------|
|                       |                           |           | ♀           |
| BRODSKY, 1950         | Central Arctic Ocean      | 400-1000  | 6.2         |
| MORRIS 1970           | South of Alaska Peninsula | 0-500     | 5.80        |
| <i>Present record</i> | Izu region                | 0-740     | 5.70, 5.77  |

## PACHYPTILUS (SARS, 1905)

### *Pachyptilus abbreviatus* (SARS, 1905)

*Pontoptilus abbreviatus* Sars, 1905, p. 19.

*Pachyptilus abbreviatus* (Sars).—Sars, 1925, p. 319, pl. 113; TANAKA, 1964b, p. 87, fig. 217; VERVOORT, 1965, p. 149; GRICE and HULSEMAN, 1967, p. 37, figs. 241-247.

*Occurrence:* Sta. 107, 1 ♀; Sta. 114, 1 ♀.

*Distribution and size variation:*

| Author                   | Locality       | Depth (m) | Length (mm) |
|--------------------------|----------------|-----------|-------------|
|                          |                |           | ♀           |
| SARS, 1925               | Off Azores Is. | 0-3000    | 3.9         |
| JESPERSEN, 1934          | Baffin Bay     | 0-1000    | 6.1         |
| WILSON, 1950             | Off Peru       | 0-540     | —           |
| TANAKA, 1964b            | Sagami Bay     | 0-1000    | 4.06        |
| VERVOORT, 1965           | Gulf of Guinea | 0-600     | 4.10-4.55   |
| GRICE and HULSEMAN, 1967 | Arabian Sea    | 350-2850  | 5.52        |
| <i>Present record</i>    | Izu region     | 0-930     | 4.01, 5.90  |

*Pachytilus eurygnathus* SARS, 1920

*Pachytilus eurygnathus* SARS, 1920, p. 18; SARS, 1925, p. 321, pl. 114; TANAKA, 1964b, p. 90, fig. 219.

*Occurrence:* Sta. 83, 1 ♀; Sta. 107, 1 ♀; Sta. 108, 1 ♀; Sta. 111-2, 1 ♀; Sta. 114, 1 ♀.

*Distribution and size variation:*

| Author                   | Locality             | Depth (m) | Length (mm) |
|--------------------------|----------------------|-----------|-------------|
|                          |                      |           | ♀           |
| SARS, 1925               | Off Lisbon           | 0-1550    | 4.80        |
| JESPERSEN, 1934          | Baffin Bay           | 0-1000    | 5.3-5.9     |
| WILSON, 1950             | Off Galapagos Is.    | 0-540     | —           |
| TANAKA, 1964b            | Sagami Bay           | 0-1000    | 5.00        |
| GRICE and HULSEMAN, 1967 | Western Indian Ocean | 350-1470  | —           |
| <i>Present record</i>    | Izu region           | 0-930     | 4.74-5.05   |

*Pachytilus pacificus* JOHNSON, 1936

*Pachytilus pacificus* JOHNSON, 1936, p. 65, fig. a 4, 5, b 1-10; BRODSKY, 1950, p. 391, fig. 279; TANAKA, 1964b, p. 88, fig. 218.

*Pachytilus eurygnathus*.—SEWELL, 1947, p. 239, fig. 65.

*Remarks:* GRICE and HULSEMAN (1967) note that the specimens recorded by SEWELL (1947) as *Pachytilus eurygnathus* are referable to *P. pacificus*.

*Occurrence:* Sta. 84-2, 1 ♀; Sta. 108, 2 ♀.

*Distribution and size variation:*

| Author                   | Locality                | Depth (m) | Length (mm) |
|--------------------------|-------------------------|-----------|-------------|
|                          |                         |           | ♀           |
| JOHNSON, 1936            | South of Aleutian Is.   | —         | 6.25        |
| SEWELL, 1947             | Arabian Sea             | 0-1000    | —           |
| BRODSKY, 1950            | Bering Sea              | 200-4000  | 5.80-6.25   |
| TANAKA, 1964b            | Sagami Bay              | 0-1000    | 5.50        |
| GRICE and HULSEMAN, 1967 | Equatorial Indian Ocean | 275-2600  | —           |
| PARK, 1970               | Caribbean Sea           | 1004-1058 | —           |
| <i>Present record</i>    | Izu region              | 0-740     | 5.97-6.18   |

## REFERENCES

This is an additional list of references, supplementing these published in our previous papers, Additional report on calanoid copepods from the Izu region, part 1 (1968), 2 (1969), and 3 (1970a, b).

- BRADFORD, J. M. 1971. The fauna of the Ross Sea. pt. 8, Pelagic Copepoda. Bull. N.Z. Dep. scient. ind. Res. 206, pp. 9-31.
- BRADY, G. S. 1883. Report on the Copepoda collected H. M. S. *Challenger* during the years 1873-76. Rep. scient. Results Challenger, Zool., vol. 8, pp. 1-142.
- BJORNBERG, T. K. S. 1963. On the marine free-living copepods off Brazil. Bolm Inst. oceanogr., S Paulo, vol. 13, pp. 3-142.
- CHIBA, T. 1956. Studies on the development and the systematics of Copepoda. (in Japanese). J. Shimonoseki Coll. Fish., vol. 6, pp. 1-90.

- CLAUS, C. 1863. Die freilebenden Copepoden mit besonderer Berücksichtigung der Fauna Deutschlands, der Nordsee und des Mittelmeers. Engelmann, Leipzig, 230 p.
- GIESBRECHT, W. and O. SCHMEIL 1898. Copepoda 1. Gymnoplea. Das Tierreich. pt. 6, 169 p.
- JOHNSON, M. W. 1936. *Pachyptilus pacificus* and *Centraugaptilus porcellus*, two new copepods from the North Pacific. Bull. Scripps Instn Oceanogr. tech. Ser., vol. 4, pp. 65-70.
- 1963. Zooplankton collections from the high Polar Basin with special reference to the Copepoda. Limnol. Oceanogr., vol. 8, pp. 89-102.
- MORRIS, B. 1970. Calanoid copepods from midwater trawls in the North Pacific along 160°E. J. Fish. Res. Bd. Can., vol. 27, pp. 2297-2321.
- PARK, T. S. 1970. Calanoid copepods from the Caribbean Sea and Gulf of Mexico. 2. New species and new records from plankton samples. Bull. mar. Sci., vol. 20, pp. 472-546.
- SARS, G. O. 1920. Calanoides recuiellis pendant les campagnes de S. A. S. le Prince de Monaco. Bull. Inst. ocnogr. Monaco, no. 377, pp. 1-20.
- SCOTT, T. 1894. Report on the Entomostraca from the Gulf of Guinea collected by John Rattray. Trans. Linn. Soc. Lond., (Zool.), ser. 2, vol. 6, pp. 1-161.
- TANAKA, O. 1964b. The pelagic copepods of the Izu region, middle Japan. Systematic account XI. Family Augaptilidae. Publs Seto mar. biol. Lab., vol. 12, pp. 39-91.
- TANAKA, O. and M. OMORI 1970a. Additional report on calanoid copepods from the Izu region. Part 3-a. *Euaetideus*, *Aetideopsis*, *Chiridius*, *Gaidius*, and *Gaetanus*. Ibid., vol. 18, pp. 109-141.
- and———1970b. Additional report on calanoid copepods from the Izu region. Part 3-b. *Chirundina*, *Undeuchaeta*, *Pseudeuchaeta*, *Valdiviella*, and *Chiridiella*. Ibid., vol. 18, pp. 143-155.
- VERVOORT, W. 1957. Copepods from Antarctic and Sub-Antarctic plankton samples. Rep. B.A.N.Z. Antarct. Res. Exped., ser. B, vol. 3, pp. 1-160.
- 1965. Pelagic Copepoda, part II. Copepoda Calanoida of the families Phaennidae up to and including Acartiidae, containing the description of a new species of Aetideidae. Atlantide Rept., no. 8, pp. 9-216.
- WOLFENDEN, R. N. 1902. The plankton of the Faroe Channel and Shetlands. Preliminary notes on some Radiolaria and Copepoda. J. mar. biol. Ass. U.K., vol. 6, pp. 344-372.